Observations on *Philobota* sp. (Lepidoptera: Oecophoridae) near Hamilton in 2012

P.J. Gerard

AgResearch, Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand
Corresponding author: pip.gerard@agresearch.co.nz

Abstract Two species of *Philobota* (Lepidoptera: Oecophoridae) have been confirmed to be present in New Zealand. These are *P. chionoptera* found near Napier and Cape Kidnappers and an unnamed species ANIC5 belonging to the *P. hydara* group found at Ruakura Research Centre, Hamilton. In spring 2012, a light trap confirmed the presence of a self-sustaining population of the latter at Ruakura. Emergence commenced 1 October, peaked on 30 October and the last moth was trapped on 3 December. Prior to the peak, males dominated the female population by 15:1, while after the peak the ratio was reduced to 1.4:1. Both mated and unmated females were collected and the maximum fecundity was 120 eggs. The moth was confirmed at a site 2 km from the Research Centre. A parasitoid, *Anacis* sp. (Ichneumonidae: Cryptini), was collected in a cage containing *Philobota* sp. ANIC5 pupae.

Keywords pasture tunnel moth, light trap, *Anacis* sp., protandry.

INTRODUCTION

Two species of the Australian pasture tunnel moth *Philobota* Meyrick (Lepidoptera: Oecophoridae) are now present in New Zealand. A single adult *P. chionoptera* Meyrick was caught near the Napier port (30 December 2010) and four adults were collected from two sites near the research house at the Cape Kidnappers Sanctuary on 7 January 2011 (B.H. Patrick, Wildland Consultants, personal communication).

Also in 2010, another *Philobota* sp. was discovered in ryegrass trials at Ruakura Research Centre in Hamilton in February 2010 (Popay & Gunawardana 2011) and sequencing by Ministry for Primary Industries (MPI) showed a 100% match with an unnamed species in the Australian National Insect Collection: this was numbered as *P.* ANIC5 by the Canadian barcoding group and belongs to the *P. hydara* species group (Common 1997).

Philobota is an Australian genus with over 400 described and undescribed species (Common 1990). A group of species in this genus (including *P. productella* (Walker), *P. diareta* Turn., *P. physaula* Meyrick and *P. chionoptera*) are collectively known as pasture tunnel moths and occasionally damage pastures and cereal crops from southern Queensland to South Australia. Most damage is reported between July and September. Recent reports of pasture tunnel moth damage in pasture and cereal crops in South Australia and Victoria featured in SARDI Entomology PestFacts (2008, 2009, 2010, 2011) and CESAR PestFacts (2008, 2009).

Very little is known about the biology of the pasture tunnel moths. They are univoltine and adults are generally observed in late spring and early summer. They are shiny white or very pale cream, with longitudinal dark streaks on the fore wings. *Philobota productella* adults congregate on tree trunks or poles to mate and the females deposit their eggs in cracks in the wood (Roberts

1982). The larvae are slender, grey in colour with a black head, and can grow up to 35 mm long and 3 mm thick. They live and pupate in vertical silk-lined tunnels in the soil as deep as 75 mm. The entrances extend 10-20 mm above the ground, and are constructed with fragments of vegetation and soil. The larvae emerge at night to feed, mainly on grasses, but also on other herbaceous plants.

Ryegrass plants in planter bags from one of the original infested trial sites identified during the 2010 MAF response (Popay & Gunawardana 2011) had been left untouched since the trial was completed. A project was initiated to ascertain if *Philobota* sp. ANIC5 was still present in this plant material, and if so, obtain newly emerged moths for formal identification, determine the adult emergence period and investigate if they could be found elsewhere around Hamilton.

MATERIALS AND METHODS

Laboratory emergence

On 28 September 2012, ten planter bags containing live ryegrass plants and likely to be infested by the *Philobota* sp. larvae were brought into the laboratory. The plants had been set up in a two-layered system: a smaller 12 cm diameter bag containing the plant in potting mix was set inside a larger 18 cm diameter planter bag containing sand (Popay et al. 2004). Roots from the plant could grow through perforations in the smaller bag and into the sand. When the outside planter bag was cut away, the sand could be gently brushed away from any larval tunnel systems. Once live *Philobota* sp. were confirmed to be present in the initial tunnels inspected, the remaining tunnel-tubes were placed in Petri dishes with minimal handling. Many of these contained a hard section with a size and shape consistent with a pupa, so food was not supplied. The Petri dishes were kept at ambient temperature in the unheated laboratory and were inspected daily for moth emergence.

Four additional planter bags were placed in 55 × 65 × 55 cm cages on the laboratory bench adjacent to the Petri dishes. These were also inspected daily for moth emergence.

All moths observed in Petri dishes or cages were collected in 7.5 ml plastic vials that were then labelled and stored in a freezer for later inspection.

Light trapping

A light trap using a 160-watt mercury lamp was set up on 28 September in an undercover open-air potting area, approximately 5 m from the nearest point of the original infested site (37° 46'S, 175° 18'E). This was operated nightly for 8 h, commencing at early dusk. The trap was inspected the following morning and *Philobota* sp. present were collected in vials and stored as above. The sex of moths collected on each date was assessed retrospectively and the size of male and female moths was compared by measuring length (mm) from head to wing tip. Adults at rest (and when dead) have their wings folded over their abdomens. A subsample of 14 females collected in October was dissected to determine mated status.

In addition, 10 Wintec Biosecurity SCBB603 students collected moths attracted to household outdoor lights in and near Hamilton city. Only one light trap was available, identical to that above. Initially it was set up adjacent to farmland at a site in Silverdale, Hamilton (37° 47'S; 175° 19'E), on 28 September. After an adult *Philobota* sp. ANIC5 had been trapped at this site, the trap was moved to a farmland site (37° 57'S; 175° 18'E) south of Ohaupo.

Statistical analyses

Regression and Zero inflated regression analyses were used to explore the relationship between catches at Ruakura and temperature and rainfall data from the Ruakura Meteorology Station located 450 m from the trap. The moth length data were analysed by ANOVA

RESULTS

Laboratory emergence

Philobota sp. ANIC5 adult emergence from caged planter bags commenced on 1 October, 2 days after placement in the unheated laboratory. No other Lepidoptera were observed. Petri dish emergence commenced on 11 October. Moths were not counted and removed on 13, 20 and 28 October so counts on following days were for a 48 h emergence period. Peak emergence in the laboratory was from 19-22 October (Figure 1).

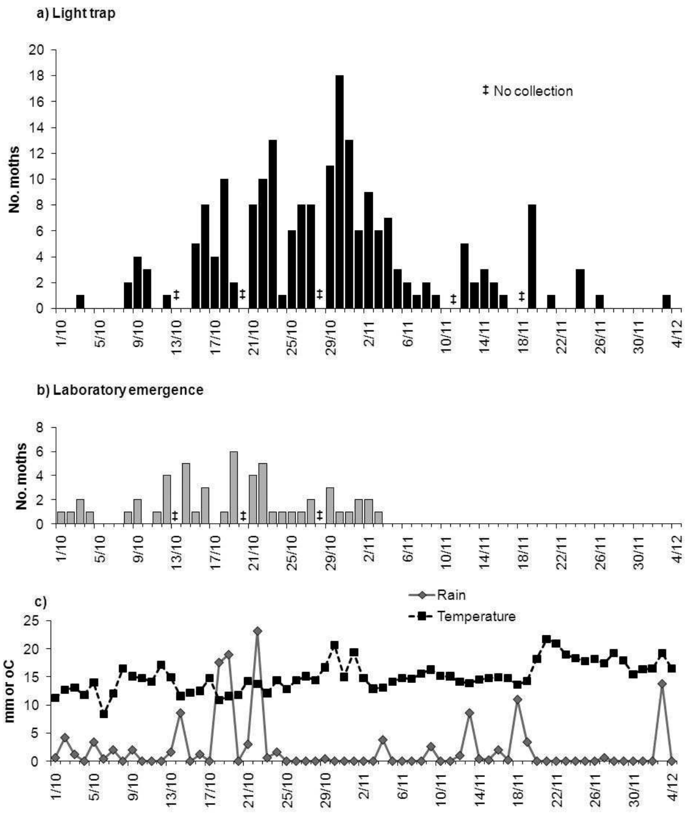

Figure 1 Pattern of (a) light trap catches, (b) laboratory emergence of *Philobota* sp. and (c) rainfall and 6 pm screen temperatures for 1 October–4 December 2012 at Ruakura Research Centre, Hamilton, New Zealand.

Most of these adults were forwarded to MPI for species identification or for addition to national, museum, university and private collections without being sexed, but of the 12 remaining in storage, seven were male and five female.

A parasitoid emerged in one of the cages on 21 October and was identified by Dr Jo Berry, Ministry for Primary Industries, as a species of *Anacis* (Ichneumonidae: Cryptini).

Light trapping

Figure 1 shows the pattern of *Philobota* sp. ANIC5 adult catches and major rainfall events at Ruakura. Trap catches commenced on 1 October and peaked on 30 October. There was no statistical relationship between evening temperatures and moths were active in cool weather with 10 moths caught on 18 October when the 6 pm screen temperature was only 10.9°C. Initially, it appeared that catches were tailing off in early November but two subsequent episodes of activity occurred that appeared to be associated with rainfall events. However, the relationships between light trap catch and rainfall were not statistically significant. The final moth caught on 3 December 2012 was also associated with rainfall. A single *Philobota* sp. ANIC5 adult was caught at the Silverdale site on 4 October but none was trapped at the Ohaupo site. No *Philobota* spp. were present in the student moth collections.

Less than one-third of moths were caught in the trap itself, while the majority were collected on a low internal wall or open mesh and wooden framing within 1 m of the trap. The moths did not appear to be strong fliers and were torpid in the morning. Both trap and wall collections were included in the catch total. Therefore, although the trap was not cleared on 13, 20 and

28 October and 10 and 18 November (Figure 1), moth collections on the following day were more likely to be around 30% larger on average, rather than 100%.

Prior to peak catch on 30 October, 94% of the population was male (35 sexed out of 95 moths collected). Females became common subsequently, although males were still dominant (28 males in the 48 moths sexed out of 106 collected). Fifty-seven percent of October females dissected had been mated. Egg complement in the ovaries ranged from 28 fully formed eggs in a mated female to 120 eggs in an unmated female. Male moth body length was on average significantly longer (12.5 mm) than female moths (11.1 mm) ($P<0.01$).

DISCUSSION

The arrival of two representatives of the pasture tunnel moth complex represents a potential threat to the New Zealand pastoral sector. There is very little published information on the genus, and nothing on the biology of these two *Philobota* species or what factors limit their populations in Australia. Therefore there is no evidence that *Philobota* sp. ANIC5 has ever been associated with pasture damage. In Australia, pasture tunnel moth is regarded as a minor pest, and the damage by this group of species is restricted to areas with greater than 500 mm rainfall (Bailey 2007) and favoured by shorter or more open, well-drained low fertility pastures, especially on the upper slopes (Roberts et al. 1982). Given rainfall will be adequate throughout New Zealand, it would be expected that if these new arrivals show similar biology to the rest of the pasture tunnel moth group, they would be most likely found on low input pastoral farms, especially on north facing hill country. Densities of over 70 pasture tunnel moth larvae/m^2 have been reported to be damaging (Bailey 2007).

Emergence and flight activity of *Philobota* sp. ANIC5 was found to be a month earlier and at much lower temperatures than observed for *P. productella* in New South Wales, Australia (Roberts 1982). The trapping of an adult at the Silverdale site on 4 October reinforces this observation. While the peak trap catch did coincide with the 6 pm temperature exceeding 20°C for the first time in October, catches in the preceding 2 weeks were associated with evening temperatures between 10 and 15°C. This suggests *Philobota* sp. ANIC5 may have a lower threshold temperature for development than *P. productella* and therefore is better adapted for New Zealand climates than the latter.

The emergence of adults in the laboratory cages commenced 1 October, 2 days after being brought inside. Emergence preceded and peaked earlier than the trap catches, probably due to warmer temperatures and even moisture levels compared to outside conditions.

The dominance of males in trap catches is similar to that observed for *P. productella* by Roberts (1982). *Philobota* sp. ANIC5 appears to display protandry, the emergence of males before females. This reduces female mating failure across a variety of population and behavioural scenarios, and aids persistence of small or spatially isolated populations (Larsen et al. 2013). Both mated and unmated females were caught in or in close proximity to the light trap and the variation in eggs found in the ovaries suggested some had already commenced oviposition. The potting shed walls were the closest vertical surfaces to the *Philobota* sp. ANIC5 infestation. It is possible that some moths were displaying similar reproductive behaviour to *P. productella*, which flies to poles and fence posts for mating and oviposition (Roberts 1982).

Until more research is undertaken, it is not possible to predict if either *Philobota* sp. ANIC5 or *P. chionoptera* will reach economically damaging levels in New Zealand. Moate et al. (2012) indicated that ryegrass infected with AR37 endophyte may reduce *Philobota* spp. larval populations and the widespread use of this and other endophytes may limit their prevalence. In addition, it may be vulnerable to parasitism by *Anacis* sp. This pupal parasitoid has been found in gum leaf skeletoniser (*Uraba lugens*) in New Zealand (Mansfield et al. 2005). The same species is present in SE Australia and has a wide host range (Dr Jo Berry, Ministry for Primary Industries, personal communication). This study provides a clear indication that October and November are the optimum months of the year when light trapping can be used to survey for the presence and distribution of *Philobota* sp. ANIC5.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of Wintec students who participated in this study as part of their Biosecurity SCBB603 course, and the advice and information provided by the Ministry for Primary Industries, Robert Hoare (Landcare Research) and Brian Patrick. The meteorological data were obtained from the NIWA National Climate Database and statistical analyses were undertaken by Maryann Pirie. This project contributes to the MBIE-funded LINX0804 Ecosystems Bioprotection programme.

REFERENCES

Bailey PT 2007. Pests of Field Crops and Pastures: Identification and Control. CSIRO Publishing, Collingwood, Victoria, Australia. 528 p.

CESAR 2008. PestFacts Issue No. 5 - 30th June 2008. www.cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern/past-issues/2008/pestfacts-issue-no-5-30th-june-2008/pasture-tunnel-moth/ (accessed 9 April 2013).

CESAR 2009. PestFacts South Eastern Issue No. 5 - 1st July 2009. www.cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern/past-issues/2009/pestfacts-issue-no-5-1st-july-2009/pasture-tunnel-moth/ (accessed 9 April 2013).

Common IFB 1990. Moths of Australia. Brian Prior Anderson, Burwood, Victoria, Australia. 576 p.

Common IFB 1997. Oecophorine genera of Australia, 2: The Chezala, Philobota and Eulechria groups (Lepidoptera: Oecophoridae). Oecophorine genera of Australia, 2: The *Chezala*, *Philobota* and *Eulechria* groups (Lepidoptera: Oecophoridae). CSIRO Publishing, Collingwood, Victoria, Australia. 407 p.

Larsen E, Calabrese JM, Rhainds M, Fagan WF 2013. How protandry and protogyny affect female mating failure: a spatial population model. Entomologia Experimentalis et Applicata 146: 130-140.

Mansfield S, Kriticos DJ, Potter KJB, Watson MC 2005. Parasitism of gum leaf skeletoniser (*Uraba lugens*) in New Zealand. New Zealand Plant Protection 58: 191-196.

Moate PJ, Williams SRO, Grainger C, Hannah MC, Mapleson D, Auldist MJ, Greenwood JS, Popay AJ, Hume DE, Mace WJ, Wales WJ 2012. Effects of wild-type, AR1 and AR37 endophyte-infected perennial ryegrass on dairy production in Victoria, Australia. Animal Production Science 52: 1117-1130.

Popay AJ, Gunawardana D 2011. *Philobota* sp. (Lepidoptera: Oecophoridae), a potential new pasture pest in New Zealand. New Zealand Plant Protection 64: 285 (abstract only).

Popay AJ, Silvester WB, Gerard PJ 2004. New endophyte isolate suppresses root aphid, *Aploneura lentisci,* in perennial ryegrass. In: Kallenbach R, Rosenkrans CJ, Lock TR ed. 5th International Symposium on Neotyphodium/Grass Interactions. Fayetteville, Arkansas, USA. p. 317.

Roberts RJ 1982. The timing and duration of the crepuscular flights and mating of the pasture tunnel moth *Philobota productella* (Walk.) (Lepidoptera: Oecophoridae). Proceedings of the 3rd Australasian Conference on Grassland Invertebrate Ecology: 57-61.

Roberts RJ, Schroder P, Davies HI, Porter MR 1982. *Philobota* (Lepidoptera: Oecophoridae) abundance in relation to different periods of withholding superphosphate application to pastures. Proceedings of the 3rd Australasian Conference on Grassland Invertebrate Ecology: 309-312.

SARDI 2008. Entomology PestFacts Issue No. 5 August 14th 2008 www.sardi.sa.gov.au/__data/assets/pdf_file/0007/78595/pestfacts__issue_5_2008.pdf (accessed 9 April 2013).

SARDI 2009. Entomology PestFacts Issue No. 11 Nov 6th, 2009. www.sardi.sa.gov.au/__data/assets/pdf_file/0011/121124/PestFacts_Issue_11_2009.pdf (accessed 9 April 2013).

SARDI 2010. Entomology PestFacts Issue No. 5 July 13th 2010. www.sardi.sa.gov.au/__data/assets/pdf_file/0006/138084/PestFacts__Issue_5_2010.pdf (accessed 9 April 2013).

SARDI 2011. Entomology PestFacts Issue No. 5 July 11th 2011. www.sardi.sa.gov.au/__data/assets/pdf_file/0006/156633/PestFacts_Issue_5_2011.pdf (accessed 9 April 2013).